COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS
FRANKFORT

HENRY WARD
COMMISSIONER OF HIGHWAYS

February 19, 1962

ADDRESS REPLY TO
DEPARTMENT OF HIGHWAYS
MATERIALS RESEARCH LABORATORY
132 GRAHAM AVENUE
LEXINGTON 29, KENTUCKY

D. 1. 7.
S. 1. 3. 4.

MEMO TO: A. O. Neiser
Assistant State Highway Engineer

During the summer of 1958, the Research Division was requested to co-operate with the Division of Maintenance in an effort to determine if an economic advantage in the over-all cost of maintaining traffic-bound surfaces could be obtained through the use of surface applications of calcium chloride. This method of calcium chloride treatment used involved only spreading the chloride over the traffic-bound macadam surface rather than inter-mixing it with the aggregate.

A project proposal consisting of selected test installations in each of the eight maintenance districts, and recommended application rates and schedules was approved and forwarded to the districts by the Maintenance Division. Initial applications were made on seven projects in the fall of 1958, and on one additional in the spring of 1959. As noted in Table 1, page 18 of the attached report, "Evaluation of Calcium-Chloride Maintained Traffic-Bound Roads," by George R. Laughlin, the schedule was not followed. It appears that some of the reasons for omitting the scheduled treatments are:

(a) Project rescheduled for paving,
(b) Budget or financial schedules,
(c) Redistricting,
(d) Reorganization of county maintenance crews.

In any case, considerably less than one-half of the scheduled applications of chloride were made.

No particular efforts were made to apply significant thickness of additional base stone. Only the normal amount of maintenance replacement stone was provided for the projects. Mr. Laughlin has pointed out that there was no significant increase in the thickness of traffic-bound base which could be attributed to this procedure during the time the roads were observed. Table 14, page 38, shows the average annual maintenance cost for all of the test roads to be $967.13 per mile. The comparable figure for the control roads was $554.40 per mile per year. This means that, on the basis of the applications made for the total test mileage, the test projects cost $312.73 more per mile annually to maintain.

No estimates of any financial benefits to motorist, crops or livestock from the dust palliative properties of calcium chloride were made inasmuch as these were not factors in the project proposal.

I am of the opinion that if any financial benefits are to be realized through aggregate retention on calcium chloride treated traffic-bound roads, it would be through the practice of intermixing the calcium with a graded base stone. This could be done following initial grading operations or upon subsequent applications of significant amounts of stone (2- to 4-in. courses). A project of this type was constructed on the Bryantsville-Beuna Vista Road in Garrard County on Project RS 40-326, in 1961. A report on this project, dated February, 1962, is available. There a graded aggregate was mixed in place and compacted to form a base for a C1 road mix surface. The treated base was left open from April to October, 1961. It appears that the treated base is performing adequately.

Respectfully submitted,

WBDrake

W. B. Drake
Director of Research

WBD:dl
Enc.
cc: Research Committee Members
Bureau of Public Roads (3)

Commonwealth of Kentucky
Department of Highways

EVALUATION OF CALCIUM-CHLORIDE MAINTAINED, TRAFFIC-BOUND ROADS

by

George R. Laughlin
Research Engineer Associate

Highway Materials Research Laboratory
Lexington, Kentucky
February, 1962

INTRODUCTION

Calcium chloride has been used on unpaved road surfaces for over fifty years. Originally, it was used as a dust palliative and later as a stabilizing agent. Observations have shown that traffic-bound roads containing well-graded aggregate and sufficient binder tend to have smooth, stable surfaces. While the binder remains in a damp, cohesive state, the road surface remains in a smooth, compact condition. If the surface becomes dry, dusting and attrition becomes pronounced. Therefore, for a properly constructed traffic-bound base to remain in smooth, stable condition, it is essential that the surface remain damp. Calcium chloride, being a hygroscopic and deliquescent material, will absorb and retain moisture in a properly constructed traffic-bound base. These properties have favored its use as a stabilizing agent in traffic-bound bases.

For stabilization of traffic-bound roads, calcium chloride may be mixed with the aggregate or applied to the road surface. When applied to the surface, the practiced procedure is to apply it in the spring of the year in sufficient quantity to retain moisture in the road surface throughout the summer; then, in the fall a second application is applied. The Calcium Chloride Institute recommends: 1) that calcium chloride be applied evenly, 2) that the base be of sufficient thickness to withstand traffic, 3) that there be sufficient roadway crown to provide adequate surface drainage, and 4) that the base be composed of properly graded aggregate having sufficient binder material to provide a compact, stable surface.

In order to evaluate the use of surface applications of calcium chloride on traffic-bound roads in the Commonwealth of Kentucky, a program was initiated in the fall of 1958. Approximately 50 miles of traffic-bound road were selected for calcium chloride maintenance. Additional traffic-bound roads were selected as control sections to be maintained in the usual way. Evaluation was based on comparative maintenance costs and the comparative condition and appearance of the test roads and control sections.

After three years of observation, a summary evaluation was made. Maintenance costs on the test roads and control sections have been tabulated and they show that the actual expenditures on the test roads have been greater than the expenditures on the control sections. This increase in cost is largely accountable by the cost of the calcium chloride and its application, all other cost-factors being more-or-less equal. The accrued improvement in thickness and in road conditions attributable directly to the use of calcium chloride seems to have been inconsequential; however, any benefits, such as those arising from the action of the chloride as a dust-palliative, could not be accounted or evaluated.

LOCATION AND DESCRIPTION OF TEST ROADS

Eight test roads, comprising 39.394 miles, received initial application of calcium chloride. The locations and descriptions of these roads are as follows:

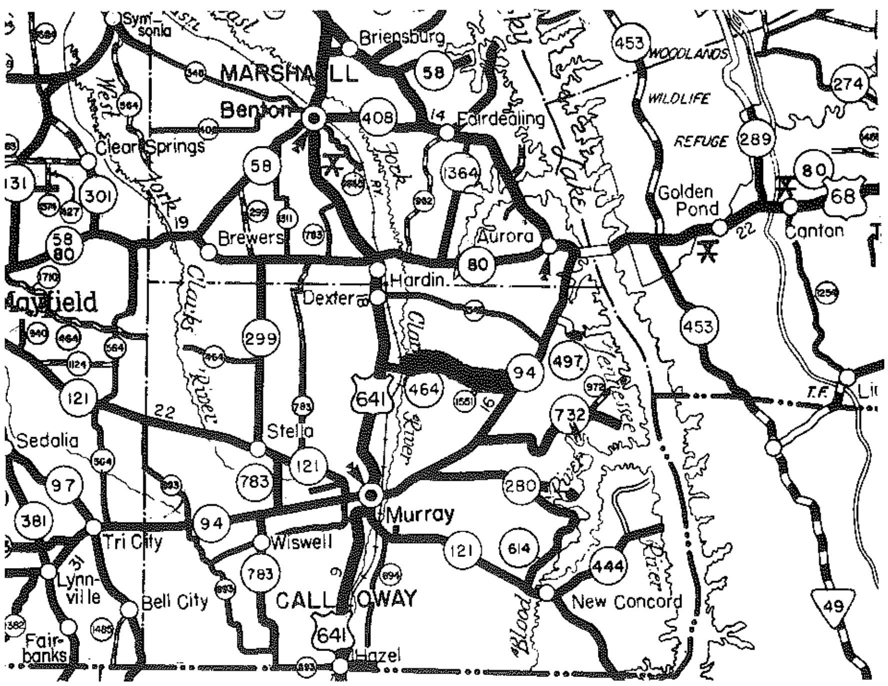

Fig. 1. Calloway County (Ky. 464) MP 018-203-D
Date of Acceptance - 8-30-58
Width of Base - 18 Feet
Type of Base - Bank Gravel
Length of Project - 6.034 Mi.

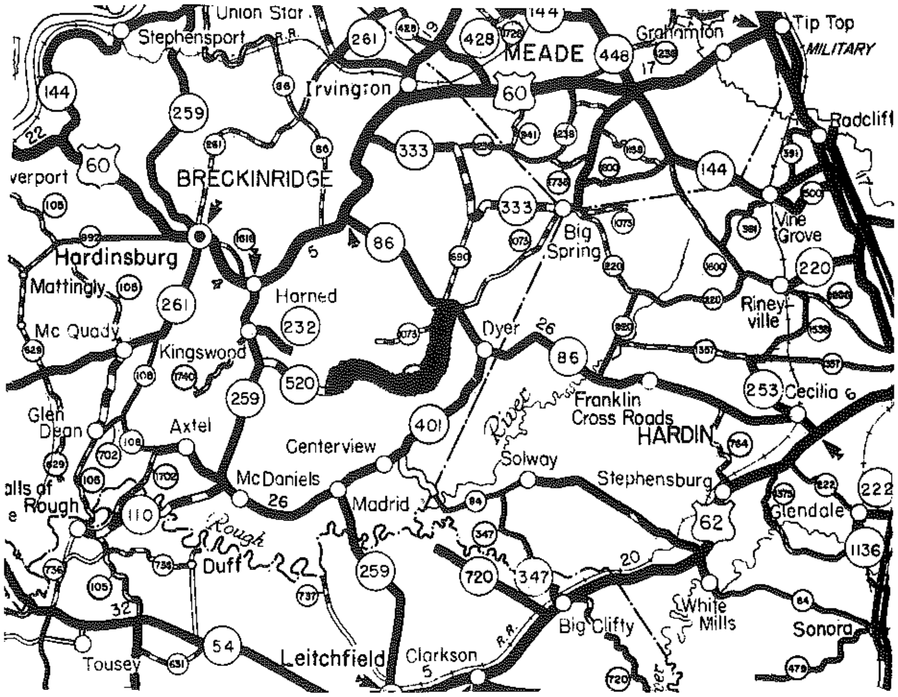

Fig. 2. Breckinridge County (Ky. 690) MP 014-733-B
Date of Acceptance - 1-20-56
Width of Base - 16 Feet
Type of Base - Crushed Limestone
Length of Project - 7.000Mi.

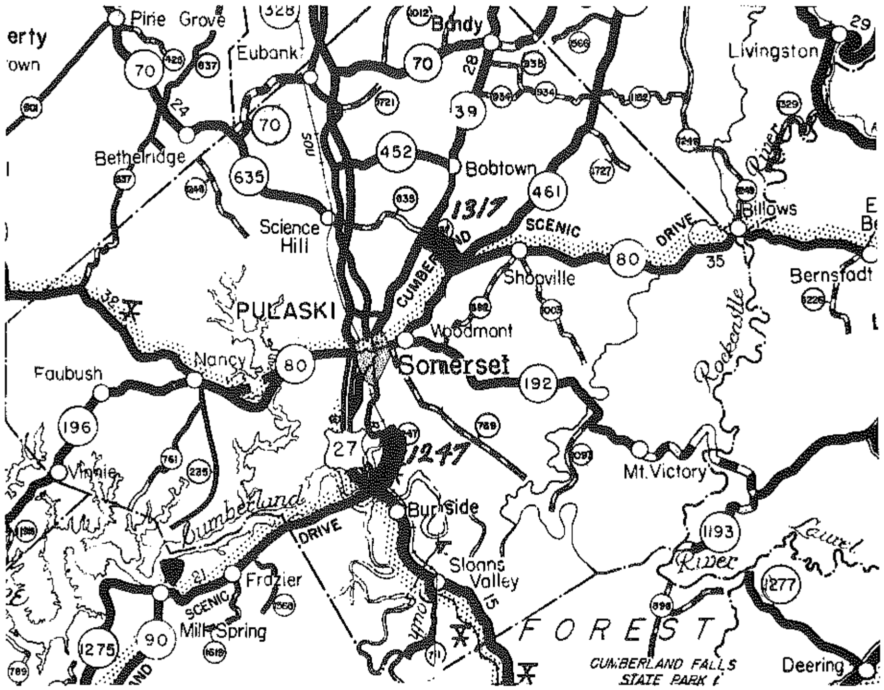

Fig. 3. Pulaski County (Ky. 1317) MP 100-25-C
Date of Acceptance - 12-12-53
Width of Base - 16 Feet
Type of Base - Crushed Limestone
Length of Project - 3.263 Mi.

(Ky. 1247) MP 100-855-E
Date of Acceptance - 10-28-53
Width of Base - 16 Feet
Type of Base - Crushed Limestone
Length of Project - 3.585 Mi.

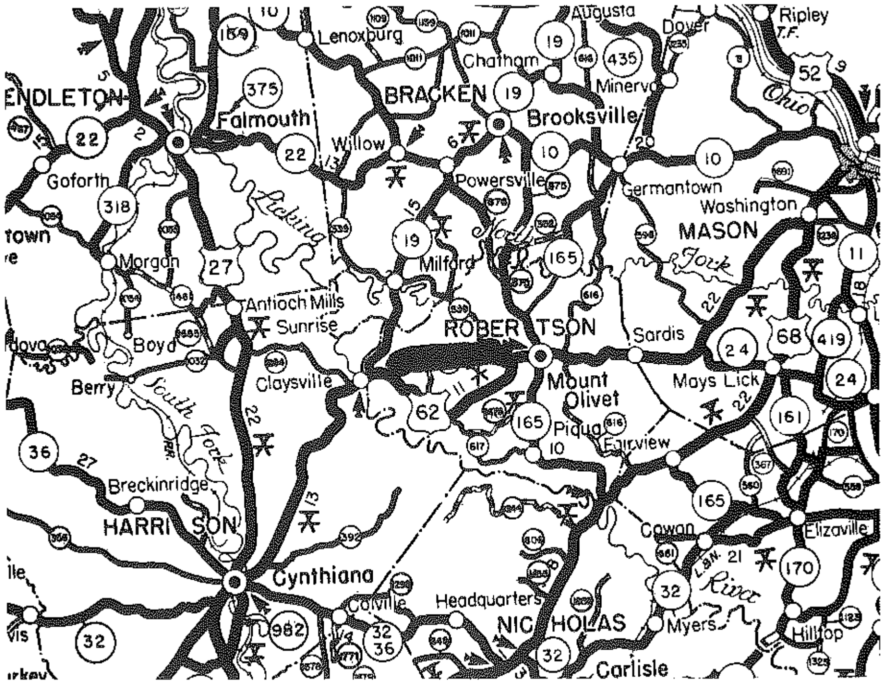

Fig. 4. Robertson County (Ky. 1504) MP 101-161-B
Date of Acceptance - 9-7-54
Width of Base - 18 Feet
Type of Base - Crushed Limestone
Length of Project - 6.889 Mi.

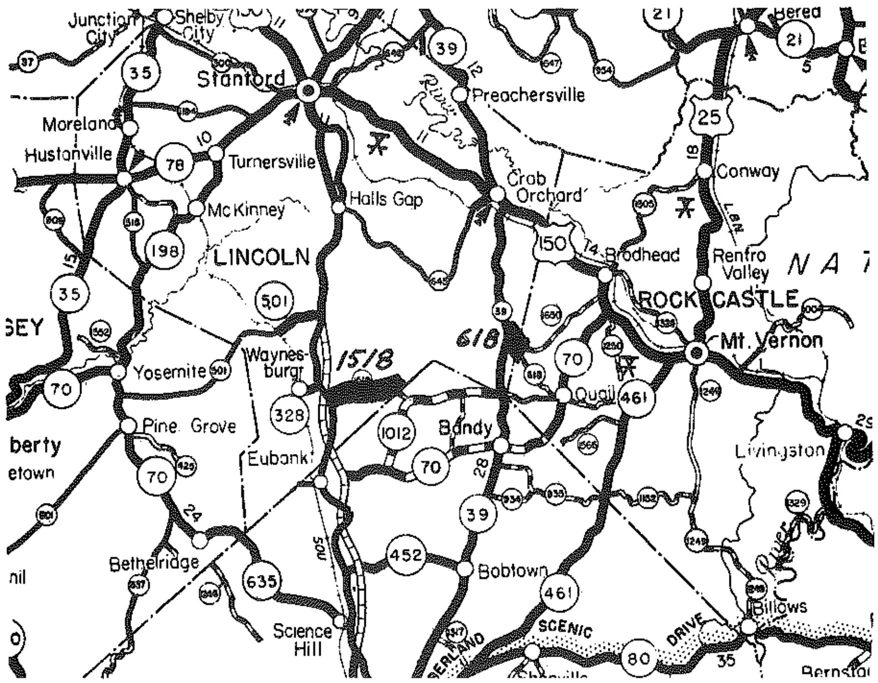

Fig. 5. Lincoln County (Ky. 1518) MP 069-450-B
Date of Acceptance - 11-23-54
Width of Base - 18 Feet
Type of Base - Crushed Limestone
Length of Project - 4.028 Mi.

(Ky. 618) MP 069-510-B
Date of Acceptance - 9-26-56
Width of Base - 16 Feet
Type of Base - Crushed Limestone
Length of Project - 1.028 Mi.

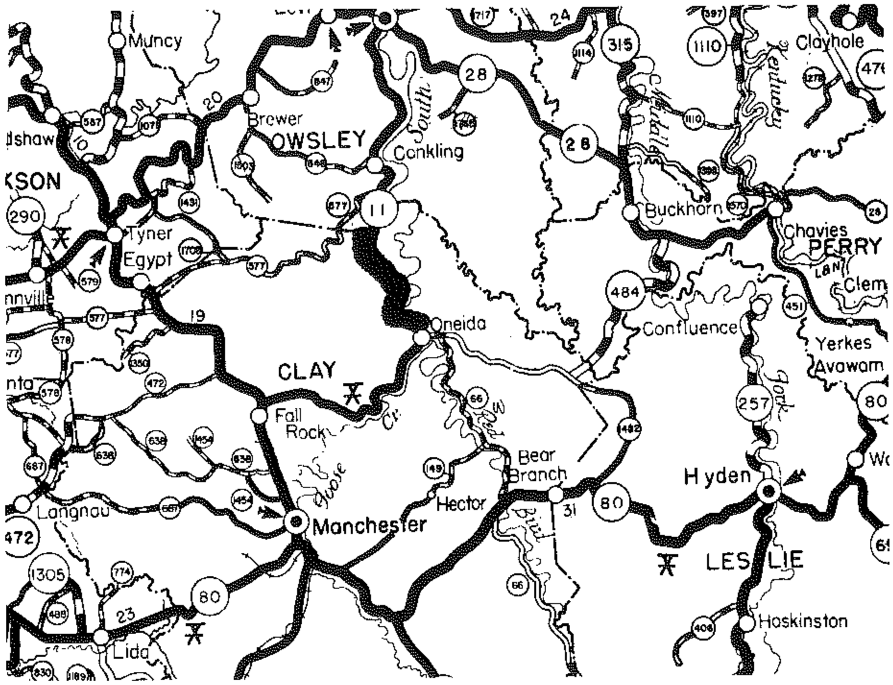

Fig. 6. Clay County (Ky. 11) MP 026-25-E
Date of Acceptance - Fall of 1958
Width of Base - 18 Feet
Type of Base - Crushed Limestone
Length of Project - 7.567 Mi.

LOCATION AND DESCRIPTION OF CONTROL SECTIONS

Five control sections comprising 21.264 miles are listed as follows:

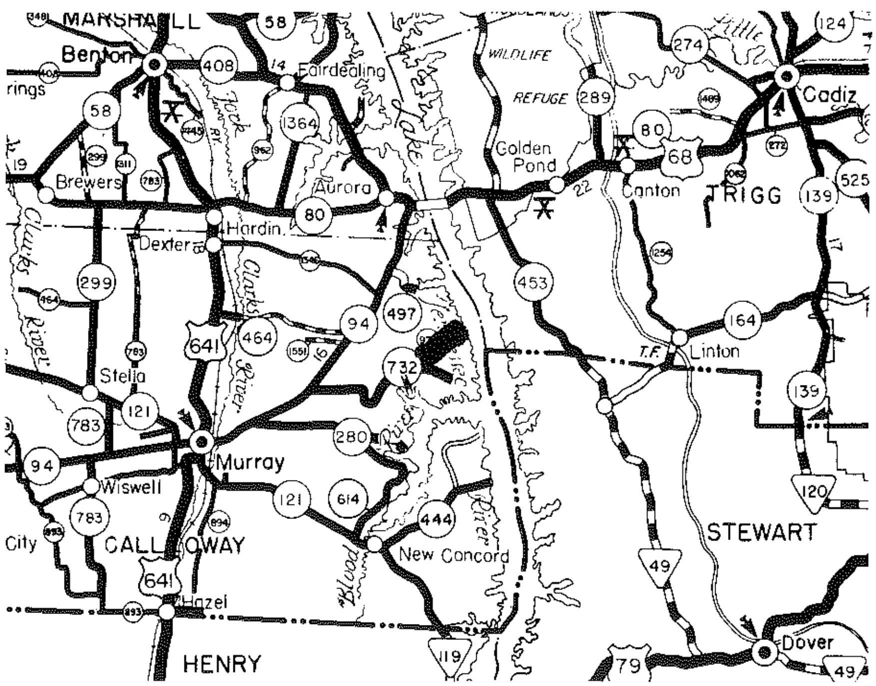

Fig. 7. Calloway County (Ky. 972) MP 018-383-A
Date of Acceptance - 7-16-48
Width of Base - 16 Feet
Type of Base - Bank Gravel
Length of Project - 2.10 Mi.

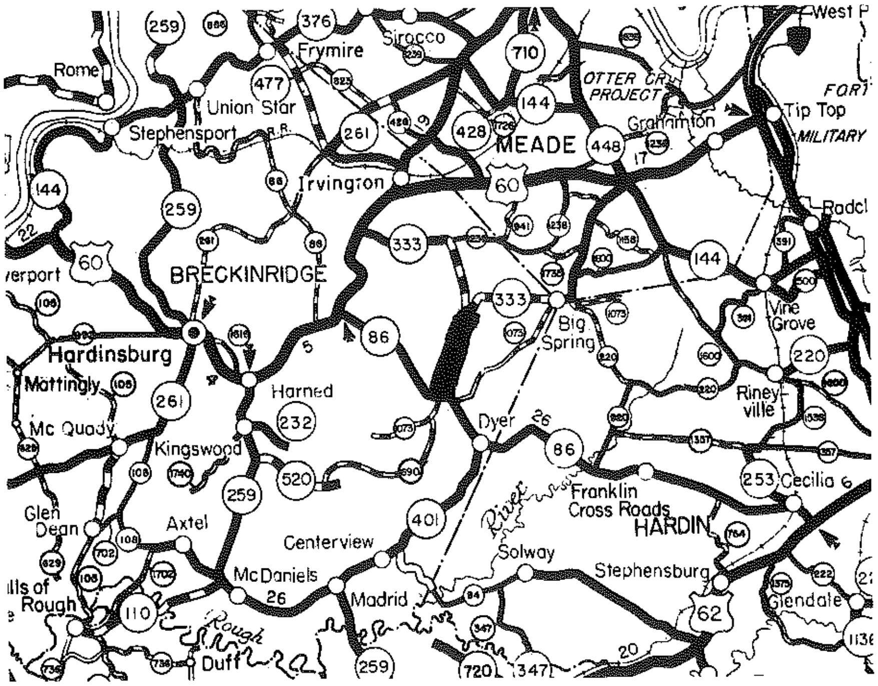

Fig. 8. Breckinridge County (Ky. 690) MP 014-513-A
Date of Acceptance - 9-24-51
Width of Base - 16 Feet
Type of Base - Crushed Limestone
Length of Project - 4.52 Mi.

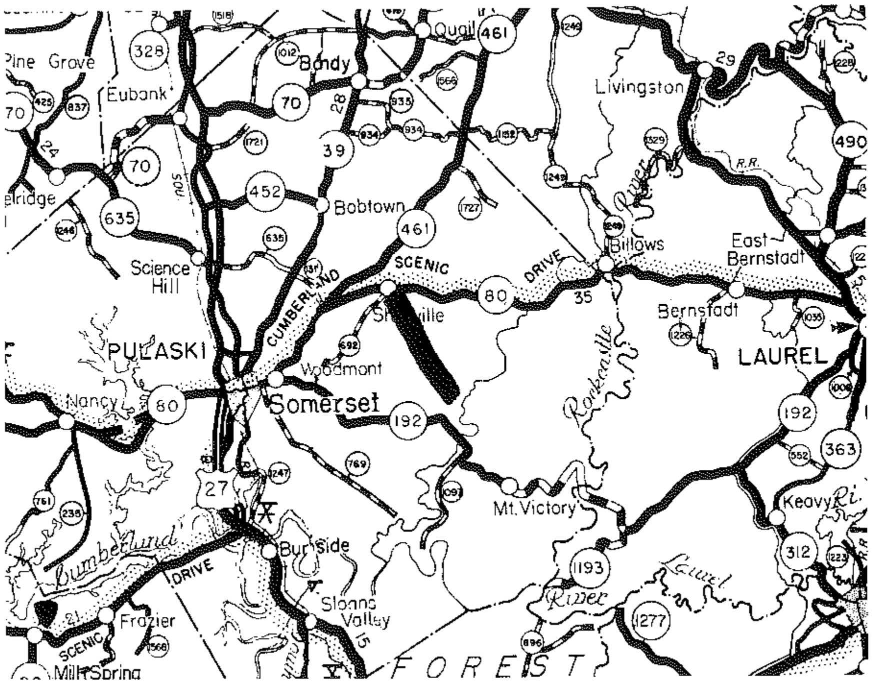

Fig. 9. Pulaski County (Ky. 1003) MP 100-695-B
Date of Acceptance - 10-5-53
Width of Base - 14 Feet
Type of Base - Crushed Limestone
Length of Project - 7.268 Mi.

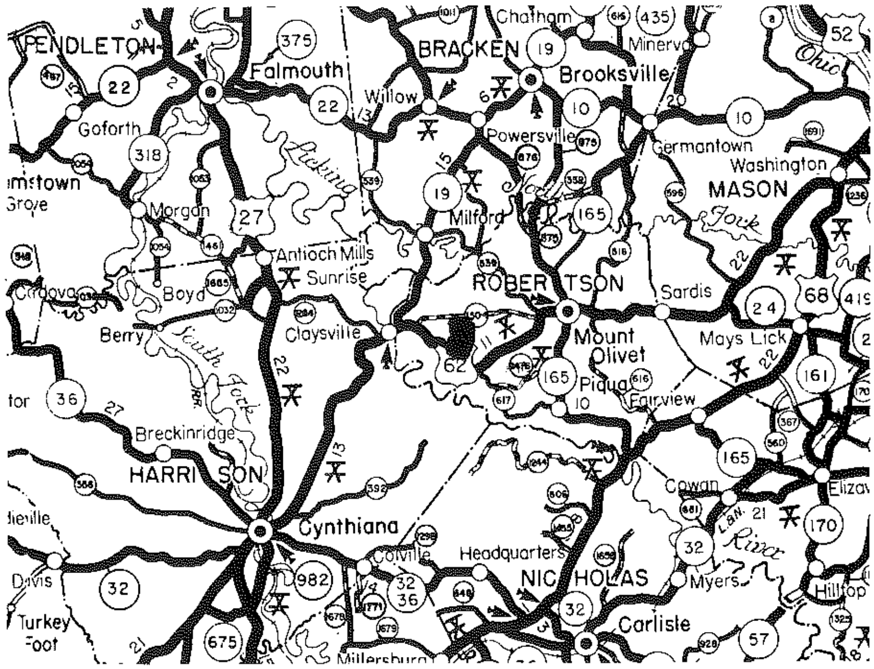

Fig. 10. Robertson County (Ky. 1521) MP 101-201-A
Date of Acceptance - 12-7-54
Width of Base - 16 Feet
Type of Base - Crushed Limestone
Length of Project - 2.280 Mi.

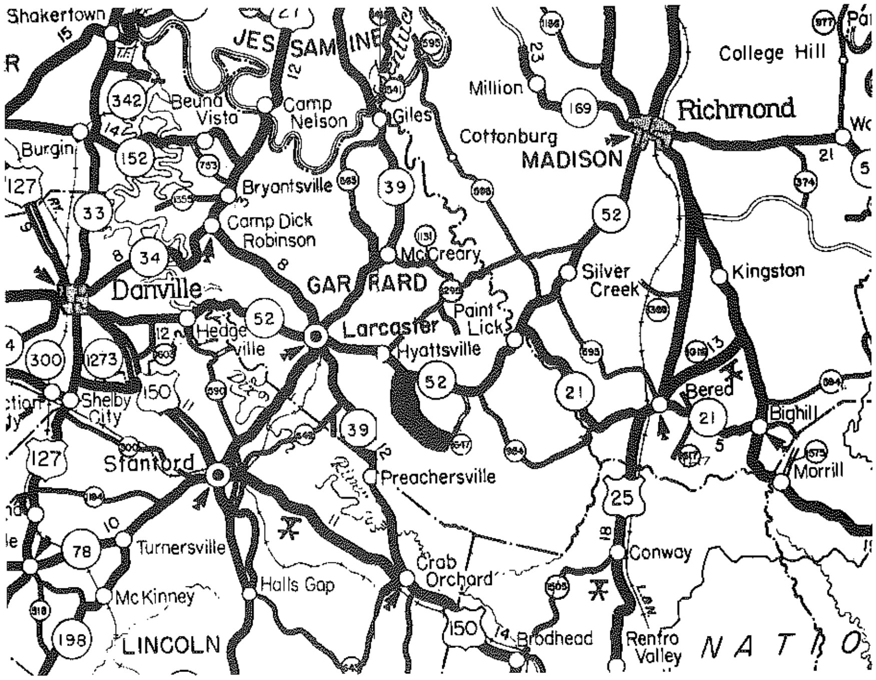

Fig. 11. Garrard County (Ky. 1647) MP 040-346-B
Date of Acceptance - 10-13-59
Width of Base - 18 Feet
Type of Base - Crushed Limestone
Length of Project - 5.096 Mi.

METHOD AND PROCEDURES

Roads selected for treatment were to be improved prior to the initial applications of calcium chloride. Where the base was of insufficient thickness, additional aggregate was to be added. Where the base was lacking in sufficient binder, the loose aggregate was to be tied down by the addition of binder soil taken from the shoulders, ditches, and back-slopes. The roadway was to be properly crowned and the ditches improved so as to give adequate surface drainage.

Initial applications of calcium chloride were to be applied at the rate of two lbs. per sq. yd. of road surface, i.e. based on the chemical concentration of the flake-type material. If anhydrous calcium chloride were to be used, the application rate was to be 1.6 lbs. per sq. yd. Thereafter, seasonal applications based on anhydrous material were to be applied at the rate of 0.8 lbs. per sq. yd. in the spring and 0.4 lbs. per sq. yd. in the fall. These application rates were in accordance with recommendations of the materials producers. The spring applications were to be placed in the latter part of the season, i.e. after the heavy rains (about May 15-30) in order to prevent excessive leaching of the material. The fall applications were to be placed about the first of August or when dusting of the road surface became noticeable.

In maintaining the test roads, blading of the surface was to have been kept to a minimum and performed only after rains when the surface was damp so as to prevent segregation of the aggregate and to assure recompaction of the road surface. All maintenance and the applications of calcium chloride were to be performed by state forces. All costs were to be accurately determined and reported monthly to the Division of Research. The monthly costs were to include the number of bladings on each test road, the amount and cost of aggregate added and the amount and cost of materials for each calcium chloride application. The Division of Research was to make periodic inspections of the test roads and control sections, to compile the surface maintenance costs and quantities of materials used on the test roads and control sections, and to evaluate the program based on maintenance costs, condition and appearance of the test roads and control sections.

The test roads selected were chosen so as to reflect a statewide average of maintenance costs on traffic-bound roads. Where possible, the control sections were chosen near the corresponding test roads so that companion sections would be subject to the judgement of the same maintenance personnel and the customary practices of the area. However, maintenance personnel were un-aware of the location of the control section and, therefore, could not consciously introduce bias into the control sections.

CALCIUM CHLORIDE APPLICATIONS

Seven test roads received initial applications of calcium chloride in the fall of 1958. An eighth project was initially treated in the spring of 1959. A total of 39 miles of test road was included in the evaluation program.

In applying the calcium chloride, six types of mechanical spreaders were employed. They were: 1) the lime drill, 2) Champion spreader, 3) Highway spreader, 4) Shunk spreader, 5) Gibbs spreader and 6) the Swenson spreader. The lime drill did not give an even application, the operation of this equipment was slow due to the frequent stops required to refill the hopper. The Champion spreader was unsatisfactory because of the slowness of operation and an excessive rate application (which could not be reduced). The Highway spreader applied the material evenly and operated satisfactorily. The Shunk spreader was more efficient in operation than the other types used. With this equipment, the application rate was consistent, the width of application was effectively controlled, and the entire operation was performed by the truck driver. Although the Gibbs spreader was efficient in applying the material, the application was uneven and frequently labor was required to unclog the equipment. The Swenson spreader was convenient to use in applying the material, but the application was uneven. The six types of spreaders used are depicted in Figs. 12 thru 17.

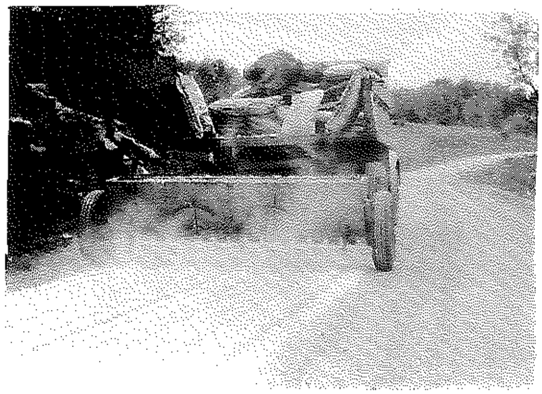

Fig. 12. Lime Drill in Operation, Uneven Application.

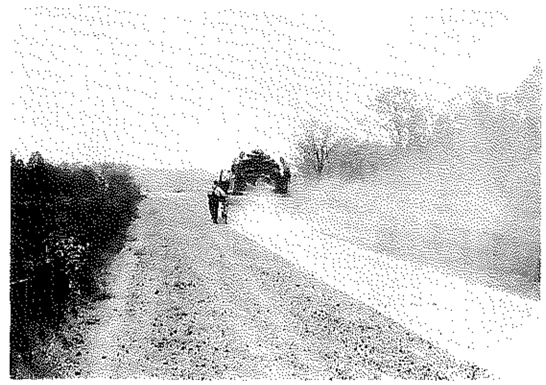

Fig. 13. Champion Spreader in Operation, Excessive Application.

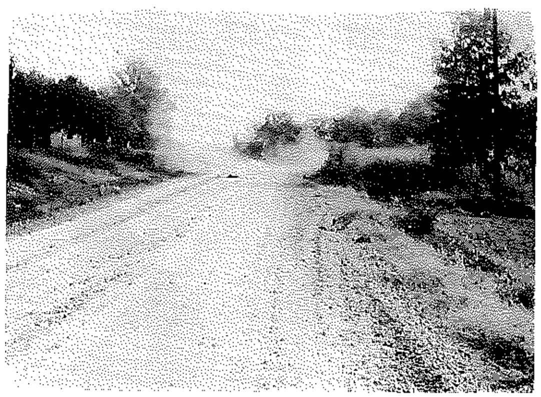

Fig. 14. Highway Spreader in Operation, Even Application.

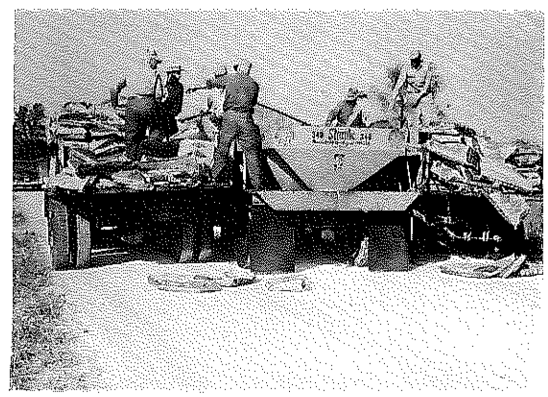

Fig. 15. Shunk Spreader in Operation, Even Application.

Fig. 16. Gibbs Spreader in Operation, Uneven Application.

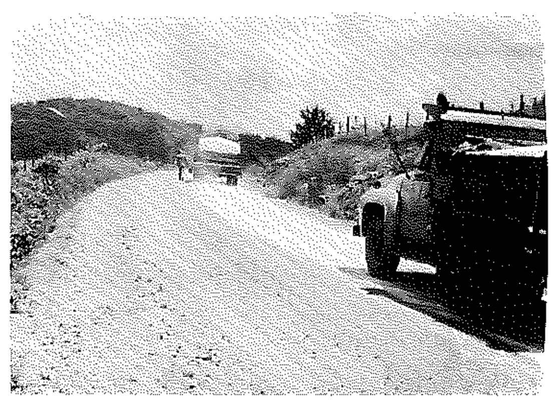

Fig. 17. Swenson Spreader in Operation, Uneven Application.

The seasonal applications of calcium chloride began in April, 1959, and continued through June, 1961. There were omissions of applications on all test roads. Two test roads did not receive the seasonal applications of calcium chloride, and two roads were deleted from the program in 1960 due to surfacing. The sequence of calcium chloride applications is tabulated as follows:

Table 1. Sequence of Calcium Chloride Applications

Description of Test Roads	Calcium Chloride Applications Initial	Second	Third	Fourth	Fifth	Sixth
Calloway Co. MP 018-203-D	10-58	none	none	none	none	none
Breckinridge Co. MP 014-733-B	9-58	none	none	none	8-60	none
Pulaski Co. MP 100-25-C	8-58	5-59	none	none	7-60	6-61
Pulaski Co. MP 100-855-E	8-58	5-59	8-59	none	paved 10-60	
Robertson Co. MP 101-161-B	10-58	none	none	none	7-60	none
Lincoln Co. MP 069-450-B	9-58	none	9-59	6-60	none	none
Lincoln Co. MP 069-510-B	9-58	none	9-59	6-60	none	none
Clay Co. MP 026-25-E	4-59	none	none	none	paved 8-60	

CONDITION AND APPEARANCE OF ROADS

Calloway County, MP 018-203-D

The bank gravel base of this road remained stable throughout the evaluation program. There was always an abundance of coarse floater on the surface. During wet seasons, water was impounded on the surface and shoulders where the crown was insufficient or lacking - giving rise to instability and bad appearance along the edges. The base thickness was sounded during periodic inspections and these thicknesses are given in Table 2. Figures 18 and 19 depict a section of this test road at the start of the evaluation program and near the end of the program.

Table 2. Base Thickness of MP 018-203-D

Location	Fall-1958	Spring-1959	Spring-1960	Spring-1961
Beginning	4.50 in.	4.50 in.	5.00 in.	4.50 in.
Middle	4.25 in.	4.50 in.	4.50 in.	5.00 in.
End	4.25 in.	4.50 in.	4.50 in.	4.25 in.
Average	4.33 in.	4.50 in.	4.66 in.	4.58 in.

Fig. 18. Calloway County, MP 018-203-D, Spring, 1959.

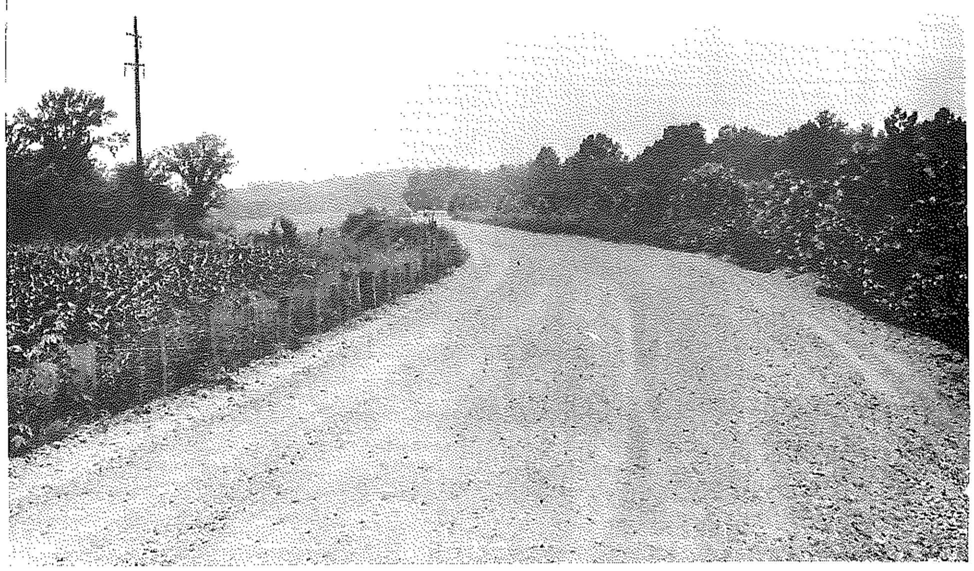

Fig. 19. Calloway County, MP 018-203-D, Summer, 1960.

Breckinridge County, MP 014-733-B

From the beginning of the evaluation period to the end, this road was observed to be unstable during the wet seasons. Since the base thickness was insufficient to withstand traffic, the surface rutted and gave rise to inadequate drainage; hence, the stability and appearance were not improved. Figures 20 and 21 depict a section of this road during the initial application of calcium chloride and in the summer of 1961. The base thickness measured during inspections of this road are given in Table 3.

Table 3. Base Thickness of MP 014-733-B

Location	Fall-1958	Spring-1959	Spring-1960	Spring-1961
Beginning	1.00 in.	1.00 in.	2.25 in.	0.75 in.
Middle	1.00 in.	1.00 in.	1.75 in.	0.50 in.
End	0.75 in.	1.00 in.	1.00 in.	2.00 in.
Average	0.92 in.	1.00 in.	1.66 in.	1.08 in.

Pulaski County, MP 100-25-C

During wet seasons, the surface of this road rutted under traffic, giving a rough appearance. Table 4 lists the thickness of the base measuring during periodic inspections. Figures 22 and 23 illustrate the condition and appearance of a section of this test road.

Fig. 20. Breckinridge County, MP 014-733-B, Fall, 1958.

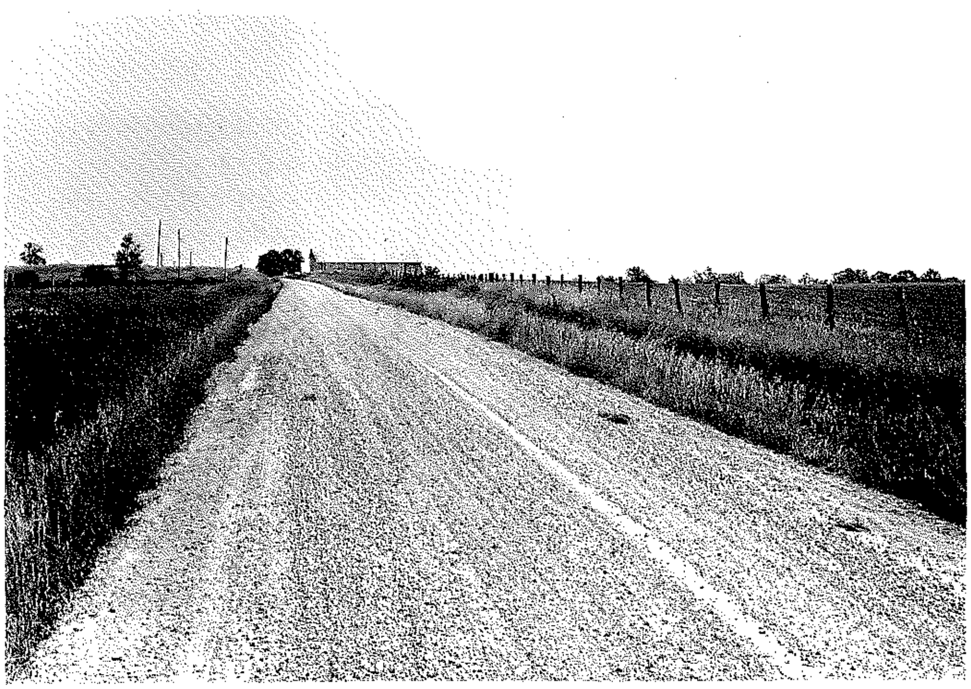

Fig. 21. Breckinridge County, MP 014-733-B, Summer, 1961.

Fig. 22. Pulaski County, MP 100-25-C, Fall, 1959.

Fig. 23. Pulaski County, MP 100-25-C, Summer, 1961.

Table 4. Base Thickness of MP 100-25-C

Location	Fall-1958	Spring-1959	Spring-1960	Spring-1961
Beginning	1.50 in.	1.50 in.	none	0.50 in.
Middle	0.50 in.	0.50 in.	0.25 in.	0.50 in.
End	3.50 in.	3.50 in.	0.75 in.	2.75 in.
Average	1.83 in.	1.83 in.	0.33 in.	1.25 in.

Pulaski County, MP 100-855-E

Although the base of this road was thin, the surface remained stable. The surface was kept highly crowned; blading was kept to a minimum and was performed when the surface was damp to ensure re-compaction of the loose material. The base thicknesses were measured during inspections and these data are given in Table 5. Figures 24 and 25 depict a typical section of this test road.

Table 5. Base Thickness of MP 100-855-E

Location	Fall-1958	Spring-1959	Spring-1960
Beginning	1.00 in.	0.75 in.	0.25 in.
Middle	0.75 in.	0.75 in.	0.25 in.
End.	0.75 in.	0.75 in.	0.75 in.
Average	0.83 in.	0.75 in.	0.41 in.

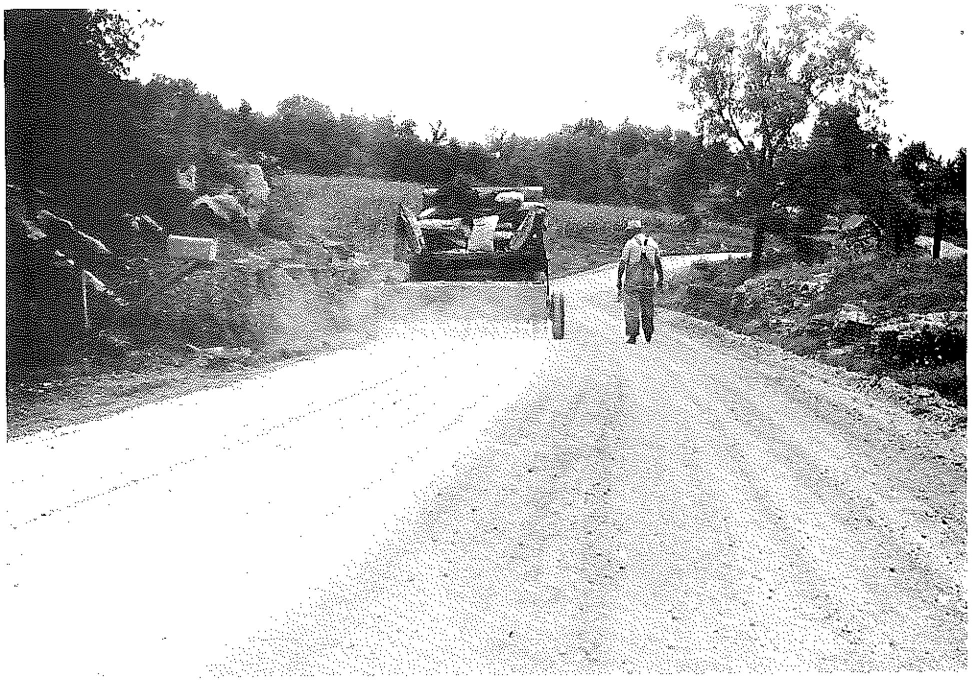

Fig. 24. Pulaski County, MP 100-855-E, Fall, 1958.

Fig. 25. Pulaski County, MP 100-855-E, Spring, 1960.

Robertson County, MP 101-161-B

Large portions of the road were unstable in wet seasons. Table 6 shows the base thickness measured during inspections. Figure 26 depicts a section of this road after the initial application of calcium chloride. Figure 27 depicts the ~~same~~ section one year later, and shows an absence of base, with large limestone remnants protruding through the surface.

Table 6. Base Thickness of MP 101-161-B

Location	Fall-1958	Spring-1959	Spring-1960	Spring-1961
Beginning	1.25 in.	1.75 in.	3.50 in.	4.00 in.
Middle	0.75 in.	0.75 in.	0.25 in.	1.75 in.
End	3.50 in.	3.50 in.	3.00 in.	2.50 in.
Average	1.83 in.	2.00 in.	2.25 in.	2.75 in.

Lincoln County, MP 069-450-B

The surface remained stable during wet seasons, but the appearance of the road was not improved. There persisted on the surface an abundance of loose aggregate. Table 7 shows the base thickness measured during the evaluation program. Figures 28 and 29 depict the appearance of a section of this test road.

Fig. 26. Robertson County, MP 101-161-B,
Fall, 1958.

Fig. 27. Robertson County, MP 101-161-B,
Fall, 1959.

Fig. 28. Lincoln County, MP 069-450-B,
Fall, 1958.

Fig. 29. Lincoln County, MP 069-450-B,
Summer, 1961.

Table 7. Base Thickness of MP 068-450-B

Location	Fall-1958	Spring-1959	Spring-1960	Spring-1961
Beginning	0.50 in.	0.50 in.	3.50 in.	0.75 in.
Middle	4.50 in.	3.50 in.	1.25 in.	0.50 in.
End	4.50 in.	5.50 in.	3.50 in.	5.00 in.
Average	3.15 in.	3.16 in.	2.75 in.	2.10 in.

Lincoln County, MP 069-510-B

The base on this road remained stable throughout the evaluation period, but an excess of coarse, loose aggregate remained on the surface. Table 8 shows the base thickness measured during inspections. Figures 30 and 31 illustrate a section of this road, showing an excess of coarse, loose aggregate.

Table 8. Base Thickness of MP 069-510-B

Location	Fall-1958	Spring-1959	Spring-1960	Spring-1961
Beginning	4.50 in.	4.50 in.	3.00 in.	3.50 in.
Middle	4.50 in.	4.50 in.	2.50 in.	6.50 in.
End	4.50 in.	4.50 in.	3.00 in.	4.00 in.
Average	4.50 in.	4.50 in.	2.83 in.	4.66 in.

Fig. 30. Lincoln County, MP 069-510-B,
Fall, 1959.

Fig. 31. Lincoln County, MP 069-510-B,
Summer, 1961.

Clay County, MP 026-25-E

The newly constructed base on this road had an average thickness of five inches at the start of the evaluation program. When deleted from the program 16 months later, due to surfacing, the thickness had remained the same. The surface was stable but contained excessive loose aggregate which detracted from its appearance. Figure 32 depicts a section of this road during the initial application of calcium chloride.

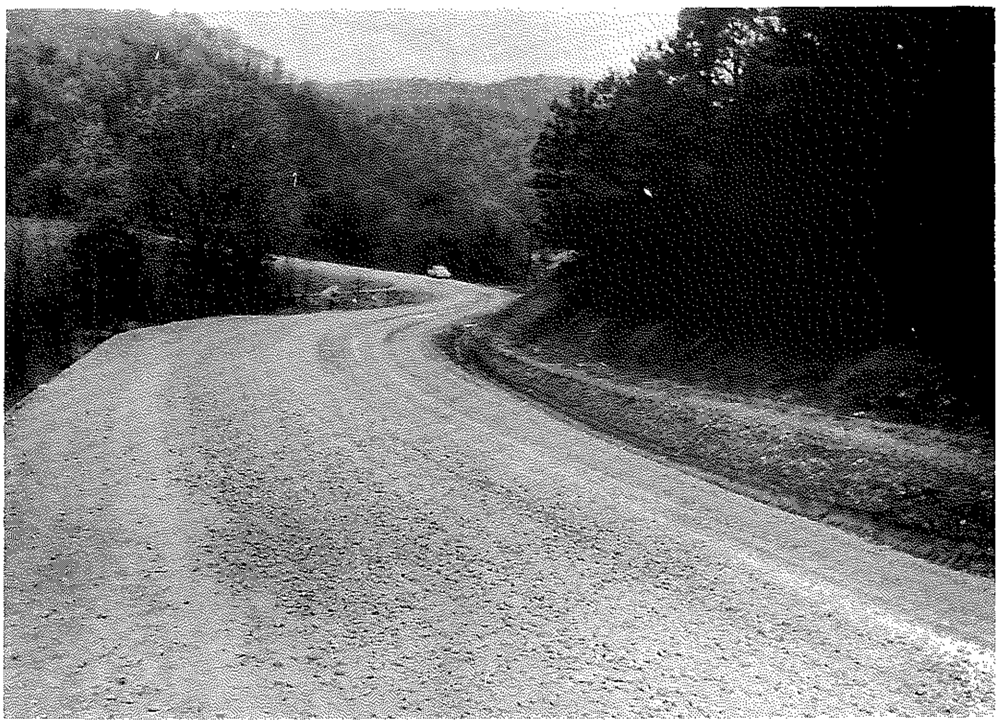

Fig. 32. Clay County, MP 026-25-E, Spring, 1959.

MAINTENANCE COSTS

The maintenance costs of the test roads and control sections were compiled from the special monthly cost forms submitted by the maintenance districts and from the general ledger forms MR-2. The tabulated expenditures and quantities of materials used in maintaining the test roads in Calloway County and Pulaski County were taken from the special monthly cost forms only. Since the special cost forms for the remainder of the test roads included only the initial applications of calcium chloride, the surface maintenance costs on these roads were compiled from the general ledger forms MR-2. All maintenance costs and quantities of materials used on the control sections were compiled from the general ledger forms. In evaluating the test roads, MP 026-25-E in Clay County was omitted due to the brief period of time that this road was included in the program and the absence of maintenance costs in the general ledger form MR-2. Since the number of bladings performed on the test roads and control sections could not be determined from the general ledger forms, this portion of the maintenance costs could not be analyzed. Tables 9 thru 14 show the cost and quantity of materials used on each test road, the cost and quantities of replacement aggregate used on the test roads and control sections, and surface maintenance costs other than calcium chloride and replacement on the test roads and the control sections.

Table 9. Calcium Chloride Applications on Test Roads

Project	Length	No. Appl.	$CaCl_2$ (tons)	$CaCl_2$ Cost in-Place	Cost per Mile per Appl.
Calloway Co. MP 018-203-D	6.034	1	50.00	$ 3434.49	$ 574.16
Breckinridge Co. MP 014-733-B	7.000	2	103.00	5807.45	414.82
Pulaski Co. MP 100-25-C	3.263	4	85.32	4933.65	378.00
Pulaski Co. MP 100-855-E	3.585	3	57.09	3653.97	339.75
Robertson Co. MP 101-161-B	6.889	2	92.20	10252.88	744.15
Lincoln Co. MP 069-450-B	4.028	3	68.50	3824.54	316.50
Lincoln Co. MP 069-510-B	1.028	3	24.38	1934.06	627.13

Table 10. Aggregate Replacement on Test Roads

Project	Aggregate Type	Aggregate (Tons)	Aggregate Cost In-Place	Maint. (Mo.)	Per Mi. Per Yr. Ton	Per Mi. Per Yr. Cost
Calloway Co. MP 018-203-D	Bank Gravel	1123.00	$ 492.00	33	67.68	$ 29.65
Breckinridge Co. MP 014-733-B	No. 6 Ls.	2108.00	5633.10	33	109.55	292.63
Pulaski Co. MP 100-25-C	No. 6 Ls.	1701.92	3738.63	33	189.67	416.64
Pulaski Co. MP 100-855-E	No. 6 Ls.	484.87	1584.34	25	64.92	212.13
Robertson Co. MP 101-161-B	No. 6 Ls.	1602.12	3617.88	33	84.57	190.97
Lincoln Co. MP 069-450-B	No. 6 Ls.	2636.50	7554.92	33	238.02	682.04
Lincoln Co. MP 069-510-B	No. 6 Ls.	1352.40	3247.46	33	478.39	1148.73

Table 11. Surface Maintenance Costs on Test Roads Excluding Calcium Chloride Applications and Replacement Aggregate

Project	Cost In-Place	Maint. (Mo.)	Cost Per Mile Per Year
Calloway Co. MP 018-203-D	$ 4654.90	33	$ 280.53
Breckinridge Co. MP 014-733-B	1855.55	33	96.39
Pulaski Co. MP 100-25-C	499.44	33	55.66
Pulaski Co. MP 100-855-E	870.07	25	116.49
Robertson Co. MP 101-161-B	6147.82	33	324.51
Lincoln Co. MP 069-450-B	4373.99	33	394.87
Lincoln Co. MP 069-510-B	1087.29	33	384.61

Table 12. Aggregate Replacement on Control Sections

Project	Aggregate Type	Aggregate (Tons)	Aggregate Cost In-Place	Maint. (Mo.)	Per Mi. Per Yr. Tons	Per Mi. Per Yr. Cost
Calloway Co. MP 018-383-A	Bank Gravel	none	none	33	none	none
Breckinridge Co. MP 014-513-A	No. 6 Ls.	1638.60	$4639.66	33	131.83	$ 373.26
Pulaski Co. MP 100-695-B	No. 6 Ls.	2813.80	7065.99	33	140.78	353.53
Robertson Co. MP 101-201-A	No. 6 Ls.	2558.00	5682.24	33	407.97	906.26
Garrard Co. MP 040-346-B	No. 6 Ls.	1407.00	4083.96	33	100.40	291.42

Table 13. Surface Maintenance Costs on Control Sections Excluding Replacement Aggregate.

Project	Cost In-Place	Maint. (Mo.)	Cost Per Mile Per Year
Calloway Co. MP 018-383-A	$ 1737.73	33	$ 300.91
Breckinridge Co. MP 014-513-A	1891.87	33	152.20
Pulaski Co. MP 100-695-B	1996.06	33	99.87
Robertson Co. MP 101-201-A	403.38	33	64.33
Garrard Co. MP 040-346-B	3916.39	33	279.46

Table 14. Summary of Actual Maintenance, per Mile per Year.

Item	Test Roads: Tons	Test Roads: Cost In-Place	Control Sections: Tons	Control Sections: Cost In-Place
Calcium Chloride	5.52	$ 445.73	--	$ --
Replacement Aggregate	126.54	297.36	144.00	367.20
Other Surface Maintenance	--	224.04	--	187.20
Total	--	967.13	--	554.40

SUMMARY

Within the period of this evaluation, no tangible economic benefits were accrued from surface applications of calcium chloride on traffic-bound roads, inasmuch as the cost of maintenance on the test roads per mile per year was considerably greater than the cost on the comparative roads. Forty-five percent of the cost of maintaining the test roads was for the calcium chloride material and its applications. As seen from Table 14, the cost of the calcium chloride in-place, per mile per year was $445.73. The state-wide average cost of maintaining the traffic-bound roads per mile was $613.96, as taken from the Statement of Expenditures, Division of Maintenance, for the fiscal period July 1, 1959, to June 30, 1960. However, aggregate replacement on the test roads averaged $297.36 per mile per year and $367.20 on the comparative roads.

Since there were omissions of calcium chloride applications on the test roads, there was lacking a basis for determining whether or not aggregate replacement might have been reduced further by strict adherence to the scheduled applications of calcium chloride.

Also due to the lack of information on the number of gradings on the test roads and the omission of some of the calcium chloride applications, it was not possible to determine whether the number of gradings were reduced by the surface applications of the calcium chloride.

The general conditions of the test roads and the control roads were not noticeably improved during the evaluation period. Where the base was of sufficient thickness to withstand traffic the road surfaces remained stable. Three test roads had bases of sufficient thickness; they were: MP 018-203-D, with an average base thickness of 4.5 inches; MP 069-450-B, with an average base thickness of 3 inches; and MP 069-510-B, with an average base thickness of 4 inches. Three test roads had bases of insufficient thickness to withstand traffic, and these were unstable in wet seasons. The base thickness on these roads ranged from 0.5 to 1.5 inches.

The smooth, compact appearance sought on the test roads was not obtained, and where replacement aggregate was added, the coarser fractions persisted in a loose state on the road. This might be interpreted as an indication that the replacement stone was either too coarse or deficient in medium-to-fine sizes.

It was not possible to evaluate the economic benefits of the chloride as a dust palliative. However, this was not a primary objective of the study.